TITLE OF INVENTION: DEBRIS SEPARATOR FOR AN AUTONOMOUS CLEANING ROBOT

FIELD

The present invention generally relates to autonomous cleaning robots, and in particular to a debris separator for such autonomous cleaning robots.

BACKGROUND

[0002] The following discussion of the background to the invention is intended to facilitate an understanding of the present invention only. It should be appreciated that the discussion is not an acknowledgement or admission that any of the material referred to was published, known or part of the common general knowledge of the person skilled in the art in any jurisdiction as at the priority date of the invention.

[0003] The Applicant develops autonomous cleaning robots, with both wet and dry vacuum capability. In their autonomous cleaning robots providing wet vacuum capabilities, they typically utilize a pair of counter rotating scrubber pads as the underlying floor cleaning tools, with water dispensed through nozzles near the floor cleaning tool to scrub the floor surface as the robot travels along a planned path to conduct the clean operation. A variation of the floor cleaning tool may comprise a cylindrical roller that has the main advantage of being smaller in size and footprint as compared to the dual scrubber pads that are more conventionally used.

[0004] The rotary cleaning action, for both the scrubber pads and the roller, agitates the floor surface to scrape/lift/pick-up debris off the floor, with the assistance of the water being introduced to soften/dissolve the debris. Having successfully lifted or agitated the debris off the floor, dirty water in the form of water together with the collected debris may then entrained within the concave region within the squeegee blades of the robot used to collect the dirty water from the floor. The front facing squeegee blade may have cut outs to allow the entrained water from entering the space between the front and rear squeegee blades. A vacuum duct may then be used to remove the dirty water collected with the squeegee blade space up off the floor. The vacuum duct then carries the dirty water into a dirty water collection tank

that is typically located within the body of the robot. The entire dirty water collection tank may be pressurized negatively by a vacuum providing motor, with the dirty water collection tank having a top hatch typically sealed with a rubber seal for air tightness. The dirty water initially passes through a debris cage located under the top latch for capturing large particulate matter and debris such as, for example, branches, leaves, and food particles. Smaller particulate matter suspended within the dirty water can however pass through the debris cage into the dirty water collection tank.

[0005] At the end of the duty cycle of the robot, the accumulated dirty water is discharged from the dirty water collection tank though a valve assembly at a robot docking station. This valve assembly may typically be in the form of an articulated ball valve, although the use of alternative valve assemblies is also envisaged. This should be an automated operation requiring no operator intervention.

[0006] The debris cage currently used in the Applicant's autonomous cleaning robots is in the form of an open top housing having an upper opening, a lower flat base and side walls. The flat base and side walls may comprise a plurality of apertures for allowing the dirty water being filtered through the debris cage to enter into the dirty water collection tank. Any large particulate matter and debris should ideally be trapped within the debris cage case, with the apertures in the base and side walls acting as a coarse filter for this purpose.

[0007] During the daily duty cycle of the autonomous cleaning robot, the debris cage can become progressively clogged with both larger and smaller particulate matter and debris, with a layer of trapped particulate matter and debris being evenly coated over the flat base of the debris cage. This can reduce the operation efficiency of the filtering by the debris cage that can result in some of the larger particulate matter and debris passing through the debris cage into the dirty water collection tank without being trapped within the debris cage. Furthermore, the apertures within the wall and base of the debris cage need to be sized to minimise clogging of the debris cage. This will then require relatively large apertures that will allow for particulate matter and debris of larger size to pass therethrough than is preferred.

[0008] In addition, within the dirty water collection tank, the solids that passes through the debris cage, settle to the bottom of the tank. This creates a sludge that

can be immediately forced through the valve assembly when a docking for discharging cycle takes place. This settling happens at all times, when at rest, and even during operation. This sludge is primarily comprised of small particulate matter and debris which can be readily discharged through the valve assembly without clogging. However, as previously mentioned, the larger particulate matter and debris like branches, leaves, food particles, which should ideally be picked up by the debris cage, can instead pass through the debris cage into the dirty water collection tank.

[0009] It is therefore possible, during the process of removing the dirty water from the dirty water collection tank at the docking station, for the valve assembly to get clogged in particular by the large particulate matter and debris, such that the valve assembly no longer closes or seals fully during normal robot operation. This results in the leaking of dirty water through the clogged valve assembly which can lead to a potential water hazard as well as being unsightly.

[0010] It is noted that the use of filters to try to improve the operation of the debris cage is not recommended. This is because the use of a filter that is too fine, traps too much particulate matter and debris too quickly. This will then require regular replacement of such filters to thereby prevent excess particulate matter and debris passing though into the dirty water collection tank to thereby avoid clogging of the valve assembly. Any clogging of the valve assembly can then lead to dirty water constantly being released through the valve assembly and dripping on the floor, negating the cleaning activity and introducing slipping hazards to the environment being serviced by the robot. A filter that is too coarse, will however create the same effect, without trapping sufficient particulate/debris within the debris cage.

[0011] An object of the invention is to ameliorate one or more of the above-mentioned difficulties.

SUMMARY

[0012] According to an aspect of the present disclosure, there is provided a debris separator for an autonomous cleaning robot comprising:

a housing having an outer side wall and a lower base defining an inner volume for

receiving dirty water therein, the dirty water being supplied to the inner volume through an egress outlet extending through the side wall;

the inner volume being divided between an entry volume having a bottom entry base portion for initially receiving the dirty water, and a separator volume having a bottom separator base portion, the entry volume and separator volume being in fluid communication, with a diverting wall being located intermediate the entry and separator volumes, the egress outlet being located adjacent the entry volume,

wherein the dirty water is initially supplied by the egress outlet to the entry volume in a flow direction towards the diverting wall to thereby allow for at least partial circulation of the dirty water within the entry volume prior to delivery to the separator volume; and

wherein the side wall surrounds the separator volume, and the base portion under the separator volume is provided with a plurality of apertures for filtering particulate and debris material from the dirty water, and for allowed passage of the now filtered dirty water therethrough.

[0013] In some embodiments, the diverting wall extends into the inner volume from the side wall, with a gap being provided between an end portion of the diverting wall and the opposing side wall.

[0014] In some embodiments, the entry volume is deeper than the separator volume.

[0015] In some embodiments, no apertures are provided in the side wall surrounding the entry volume, and the bottom entry base portion thereof.

[0016] In some embodiments, the apertures of the bottom separator base portion of the separator volume extend in a generally grid pattern thereon.

[0017] In some embodiments, the grid pattern is generally aligned with an adjacent side wall of the diverting wall.

[0018] In some embodiments, the apertures of the bottom separator base portion are generally square in shape.

[0019] In some embodiments, the apertures of the side wall surrounding the separator volume extend in a series of generally vertical rows along the side wall.

[0020] In some embodiments, the apertures of the side wall surrounding the separator pattern are generally rectangular in shape.

[0021] Other aspects and features will become apparent to those of ordinary skill in the art upon review of the following description of specific embodiments in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

In the figures, which illustrate, by way of example only, embodiments of the present invention,

[0022] [Figure 1] is a plan view of a debris separator for an autonomous cleaning robot according to the present disclosure;

[0023] [Figure 2] is an end view of the debris separator of fig. 1;

[0024] [Figure 3] is a side view of the debris separator of fig. 1;

[0025] [Figure 4] is a cross-sectional view taken along line A-A of the debris separator of fig. 3; and

[0026] [Figure 5] is a perspective view of the debris separator of fig. 1.

DETAILED DESCRIPTION

[0027] Other arrangements of the invention are possible and, consequently, the accompanying drawings are not to be understood as superseding the generality of the preceding description of the invention.

[0028] Throughout this document, unless otherwise indicated to the contrary, the terms “comprising”, “consisting of”, “having” and the like, are to be construed as non-exhaustive, or in other words, as meaning “including, but not limited to”.

[0029] Furthermore, throughout the specification, unless the context requires otherwise, the word “include” or variations such as “includes” or “including” will be

understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

[0030] Example embodiments of the present invention will now be described with reference to the accompanying drawings. The terminology used herein is for the purpose of describing particular embodiments only and is not intended to limit the scope of the present invention. Other definitions for selected terms used herein may be found within the detailed description of the invention and apply throughout the description. Additionally, unless defined otherwise, all technical and scientific terms used herein have the same meanings as commonly understood by one or ordinary skill in the art to which this invention belongs. Where possible, the same reference numerals are used throughout the figures for clarity and consistency.

[0031] Furthermore, terms such as ‘upper’, ‘lower’ and ‘side’ are used to refer to the typical orientation of feature of the present invention when in use, and is not intended to restrict the scope of the invention.

[0032] [Figs. 1 to 5] respectively show different views of a debris separator 1 for an autonomous cleaning machine according to the present disclosure. A possible embodiment of the debris separator 1 comprises a housing 3 having an outer side wall 5 and a lower base 7. The housing 3 defines an inner volume 9 for receiving dirty water therein, the dirty water being supplied to the inner volume 9 through an egress outlet 11 extending through the side wall 5.The inner volume 9 is divided between an entry volume 15 having a bottom entry base portion 17 for initially receiving the dirty water, and a separator volume 19 having a bottom separator base portion 21, the entry volume 15 and separator volume19 being in fluid communication with the entry volume 15, with a diverting wall 23 being located intermediate the entry and separator volumes, the egress outlet 11 being located adjacent the entry volume 15.

[0033] During operation of the debris separator 1, the dirty water is initially supplied by the egress outlet 11 to the entry volume 15 in a flow direction towards the diverting wall 23 to thereby allow for at least partial circulation of the dirty water within the entry volume 15 prior to delivery to the separator volume 19. The side wall 7 surrounding the separator volume 19, and the base portion 21 under the separator volume is

provided with a plurality of apertures 25, 27 for filtering large particulates and debris material from the dirty water, and for allowed passage of the now filtered dirty water therethrough. This filtered dirty water can then be delivered into a dirty water collection tank (not shown) that is located within the body of the autonomous cleaning robot.

[0034] As shown in particular in [figs. 1, 4 and 5], the diverting wall 23 extends into the inner volume from the side wall 5. As shown in [fig. 4], the dirty water exiting the egress outlet 11 is directed towards the diverting wall 23. In the possible embodiment of the debris separator 1 according to the present disclosure, the centre of the egress outlet 11 is positioned, for example, at an angle of 158.0 degrees relative to a plane of a side wall 24 of the diverting wall 23. The diverting wall 23 further has an end portion 26 that defines a gap 28 of, for example, 40mm between the end portion 26 and the egress outlet 11. Furthermore, the entry volume 15 is deeper than the separator volume 19, with the bottom entry base portion 17 of the entry volume 15 being spaced 22 mm lower than the bottom separator base portion 21 of the separator volume 19 as shown in [fig. 2]. This helps to ensure that the dirty water circulates for a time within the entry volume 15 before flowing into the separator volume 19 thereby extending the time at which the dirty water is retained within the debris separator 1. This allows at least some of the larger particulate matter and debris to settle into the bottom of the entry volume 15. The bottom entry base portion 21 is located lower than the bottom separator base portion 21 to facilitate the settling of this particulate and debris into the deeper entry volume 15 while minimising the agitation of the settled particulate matter and debris by the slowing circulating dirty water passing above that settled material.

[0035] The larger particulates and debris material of the dirty water can also be filtered when passing through the separator volume 19 into the dirty water collection tank. This filtering is achieved by apertures 25 provided within the the bottom separator base portion 21. These apertures 25 extend in a generally grid pattern thereon and aligned with the side wall 24 of the diverting wall 23. Furthermore, the apertures 25 are generally square in shape as shown in [fig. 1]. Apertures 27 are also provided on the side walls 5 surrounding the separator volume 19. These apertures 27 extend in a series of generally vertical rows along the side wall 5. Furthermore,

these apertures 27 are generally rectangular in shape. The size of the apertures 25,27 may also be smaller in size than the apertures used in known debris cages because of the longer dwell time that the dirty water is within the debris separator 1. It is however to be appreciated that the use of alternative aperture patterns and shapes are also envisaged.

[0036] The bottom entry base portion 17 and the side wall 5 surrounding the entry volume 15 may not be provided with any apertures in the described debris separator 1 according to the present disclosure. It is however also envisaged that apertures be provided within the entry volume 15 if required/desired.

[0037] The operational efficiency of the debris separator 1 according to the present disclosure is therefore improved over known debris cages by extending the dwell time that the dirty water is retained within the inner volume 9 of the debris collector 1 which allows a greater amount of the larger particulate and debris to settle and be retained within the debris collector 1. This material can sink by gravity, in particular into deeper portions of the entry volume of the 15 of the debris separator 1.

[0038] The debris separator 1 according to the present disclosure provides a number of advantages over known debris cages. The configuration of the debris separator acts to slow the flow of dirty water passing therethrough. This then allows more time for particulate matter and debris to settle within the debris separator 1 through gravity and density. This results in more of the larger particulate matter and debris to be trapped within the debris separator 1 thereby minimising the amount of this material entering the dirty water collection tank. This then helps to ensure that the possibility of clogging of the valve assembly is minimised thereby preventing the leaking of dirty water therefrom.

[0039] It should be appreciated by the person skilled in the art that the above invention is not limited to the embodiment described. It is to be appreciated that modifications and improvements may be made without departing from the scope of the present invention.

[0040] It should be further appreciated by the person skilled in the art that one or more of the above modifications or improvements, not being mutually exclusive, may be further combined to form yet further embodiments of the present invention.

CLAIMS

[Claim 1] A debris separator for an autonomous cleaning robot comprising:

a housing having an outer side wall and a lower base defining an inner volume for receiving dirty water therein, the dirty water being supplied to the inner volume through an egress outlet extending through the side wall;

the inner volume being divided between an entry volume having a bottom entry base portion for initially receiving the dirty water, and a separator volume having a bottom separator base portion, the entry volume and separator volume being in fluid communication, with a diverting wall being located intermediate the entry and separator volumes, the egress outlet being located adjacent the entry volume,

wherein the dirty water is initially supplied by the egress outlet to the entry volume in a flow direction towards the diverting wall to thereby allow for at least partial circulation of the dirty water within the entry volume prior to delivery to the separator volume; and

wherein the side wall surrounds the separator volume, and the base portion under the separator volume is provided with a plurality of apertures for filtering particulate and debris material from the dirty water, and for allowed passage of the now filtered dirty water therethrough.

[Claim 2] A debris collector according to claim 1, wherein the diverting wall extends into the inner volume from the side wall, with a gap being provided between an end portion of the diverting wall and the opposing side wall.

[Claim 3] A debris collector according to claim 1 or 2, wherein the entry volume is deeper than the separator volume.

[Claim 4] A debris collector according to claim 3, wherein no apertures are provided in the side wall surrounding the entry volume, and the bottom entry base portion thereof.

[Claim 5] A debris collector according to any one of the preceding claims, wherein the apertures of the bottom separator base portion of the separator volume extend in a generally grid pattern thereon.

[Claim 6] A debris collector according to claim 5, wherein the grid pattern is generally aligned with an adjacent side wall of the diverting wall.

[Claim 7] A debris collector according to claim 5 or 6, wherein the apertures of the bottom separator base portion are generally square in shape.

[Claim 8] A debris collector according to any one of the preceding claims, wherein the apertures of the side wall surrounding the separator volume extend in a series of generally vertical rows along the side wall.

[Claim 9] A debris collector according to claim 8, wherein the apertures of the side wall surrounding the separator pattern are generally rectangular in shape.